Center Innovation Fund: MSFC CIF

Technology Development for Ultra-High-Resolution X-ray Optics

Completed Technology Project (2012 - 2012)

Project Introduction

Readiness of the fabrication method is needed to justify future NASA astrophysics & heliophysics Missions.We propose to develop a novel optics fabrication method capable of fulfilling this demand for high-resolution, large-effective-area, affordable x-ray optics.The intent is to change the optical fabrication philosophy by starting the process with naturally-flat, thin silicon wafers and form them into very-light-weight, sub-arcsecond-resolution mirrors to be installed into a telescope structure

The goal of this proposed study is to demonstrate viability of a novel optics fabrication method that would ultimately make high-resolution, very large effective area x-ray optics affordable. The scientific community desires sub-arcsecond angular resolution and few-square-meter-effective-area x-ray optics for future large, and mid size NASA missions. This means that future x-ray telescopes must have the same or better angular resolution and more than order of magnitude larger effective area than the Chandra Observatory, but within manageable cost budgets and mass limits. Since the cost to build the Chandra optics (0.25 arcsecond resolution and 0.08 sq. m. effective area) was $0.5 billion in 1999 prices, the use of the traditional figuring and polishing techniques to fabricate the x-ray optics for future high-resolution, large effective area instruments are cost prohibitive. Thus, the astronomical x-ray optics fabrication philosophy needs to be changed to meet the scientific community expectations. Currently, the conventional approach to building light-weight, low-cost, large-effective-area x-ray optics is to trade off angular resolution for increased mirror area through replication techniques. In these, thin optics are obtained by replication from super-polished and figured masters, then aligned and assembled into a telescope structure. During the replication process, which is done at MSFC via electroforming, small stresses are always imparted in to the shell. Separation of the thin replica from the master leads to releasing of this stress, which then results in unwanted figure deformations of the replica surface. Further, localized forces at the support points introduce additional surface deformations during the replica optics alignment process. As a result, the state-of-the-art performance for replicated optics is currently about 10 arcsecond angular resolution. Another approach to building up effective area for x-ray telescopes is to use so-called pore optics.

Anticipated Benefits

Availability of high resolution, large effective area, light-weighted x-ray optics for future astrophysics and heliophysics missions within manageable cost budgets.

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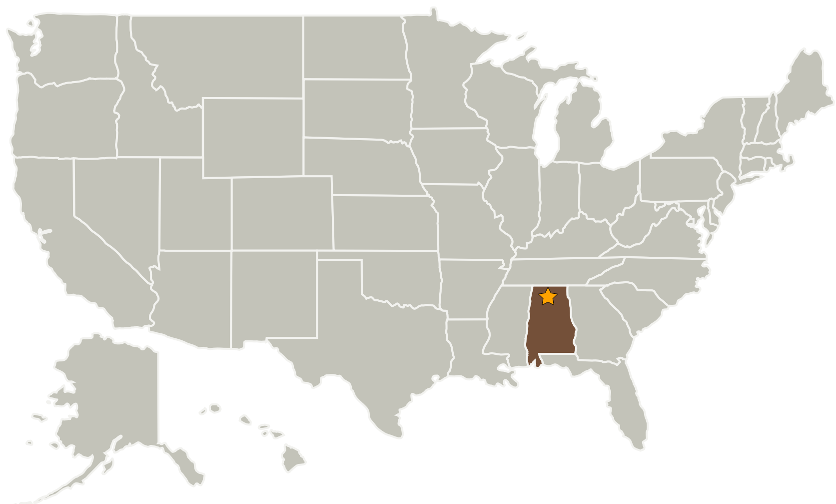
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Marshall Space Flight Center(MSFC)	Lead Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations
Alabama

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Marshall Space Flight Center (MSFC)

Responsible Program:

Center Innovation Fund: MSFC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

John W Dankanich

Project Manager:

Mikhail V Gubarev

Principal Investigator:

Mikhail V Gubarev

Center Innovation Fund: MSFC CIF

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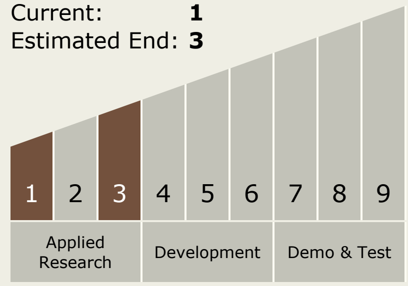
Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **3**



Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  └─ TX12.4 Manufacturing
    └─ TX12.4.3 Electronics and Optics Manufacturing Process